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ORIGINAL ARTICLE

Role of multi-detector computed tomography in the evaluation of pancreatic tumors



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KEYWORDS

MDCT;
Pancreas;
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Abstract *Objective:* The purpose of this study was to determine the role of multidetector computed tomography (MDCT) in evaluation and prediction of pancreatic tumors resectability.

Patients and methods: The study included 20 patients who had pancreatic masses, 16 males and 4 females, and their age range was 30–70 years with a mean age of 58.0 years. All the patients underwent non-contrast and contrast enhanced Multi-slice CT using a 16-slice machine. The gold standard for diagnosis was histopathology and operative data.

Results: Adenocarcinoma as reported by pathological studies was found in 8 patients, cyst adenocarcinoma in one patient, infiltrative adenocarcinoma in 2 patients, intraductal papillary mucinous tumor in 2 patients, mucinous cyst adenocarcinoma in one patient, pancreatic pseudo cyst in 2 patients and mucinous cystadenoma in 4 patients. According to MDCT criteria 6 patients were considered suitable for tumor resection and 14 patients were considered inoperable with unresectable tumor, one out of the 6 operable patients was unresectable during operation due to the invasion of the superior mesenteric vein with infiltration of the mesenteric root.

Conclusion: Contrast-enhanced multiphase pancreatic imaging by multislice computerized tomography (MSCT) with its postprocessing techniques represents the image of choice for diagnosis and predicting pancreatic masses and resectability.

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Abbreviations: MDCT, multidetector CT; MSCT, multislice CT; MPR, multiplanar reformation

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1. Introduction

Imaging of the pancreas is challenging because of its anatomic location in the retroperitoneum and its intricate relationship with major blood vessels and bowel. Computed tomography (CT) has been the initial imaging modality of choice for evaluation of pancreatic pathology (1).

Pancreatic cancer is the fourth most frequent cause of cancer-related death. The incidence is increasing and the overall survival has been altered a little in recent years (2). The overall 5 years survival rate of pancreatic cancer ranges from 0.4% to

Table 1 Age and sex frequency distribution of the studied 20 patients with pancreatic mass.

Age	Female		Males		Total	Percentage (%)
> 30–40	0	0	1	5%	1	5
> 40–50	2	10%	3	15%	5	25
> 50–60	2	10%	10	50%	12	60
> 60–70	0	0%	2	10%	2	10
Total	4	20%	16	80%	20	100

Table 2 Show different multislice CT manifestations of the pancreatic masses detected in the studied 20 patients.

Multislice CT manifestation	Number of the patients	Percentage (%)
Margin		
Ill-defined	12	60
Well-defined	8	40
Density pattern		
Mixed	11	55
Hypodense	7	35
Hyperdense	2	10
Pattern of enhancement		
Homogenous	11	55
Heterogeneous	9	45
Calcification	1	5

4%, the lowest for any cancer. Currently surgical resection offers the best chance of cure, however more than 80% of patients present with advanced and unresectable disease. The key to increase resection rates of pancreatic cancer lies with early diagnosis (3).

Recent improvements in imaging techniques have made it possible to improve the diagnostic accuracy for detection, staging, and indicating surgical resectability of pancreatic cancer (4). Improvements in CT technology during the past decade, with fast image acquisition and improved spatial resolution, have increased the accuracy of CT for lesion detection and characterization. Axial CT images are not sufficient to demonstrate the complex anatomy of the pancreas and have made it mandatory to have multiphasic and multiplanar imaging of the pancreas (5).

Multislice CT is the most efficient non invasive technique in the assessment of pancreatic cancer, multislice CT allows excellent visualization of the pancreatic cancer during the different stages of contrast enhancement, thereby facilitates detection of small pancreatic lesions and evaluation of peripancreatic structures. 3D multiplanar reformatted images can be used to solve different diagnostic problems and to help communicate findings to clinicians (6).

The aim of this study was to determine the role of multidetector computed tomography (MDCT) in evaluation and prediction of pancreatic tumors resectability.

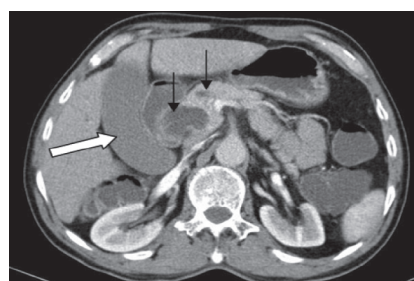
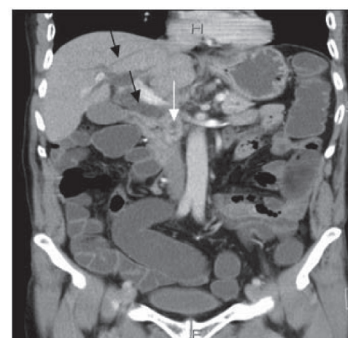
**(A) Axial non contrast CT****(B) Axial contrast enhanced CT at portal phase****(C) Axial contrast enhanced CT at Portal phase at higher level****(D) Curved multiplanar reformatting projection**

Fig. 1 (A–D) 62 year old male patient presented with jaundice, vomiting and epigastric pain (A)-**Pre-contrast CT** scan shows pancreatic head mass (white arrow). (B & C)-**Post-contrast CT** scan shows a small ill defined relatively mildly enhanced pancreatic head mass (white arrow), marked dilatation of the CBD and the pancreatic duct (black arrows) also GB is markedly distended (block arrow). (D)-**Curved multiplanar reformatting** shows dilated intrahepatic bile ducts and CBD (black arrows) that end abruptly by the mass (white arrow). **Excised Biopsy revealed:** *pancreatic adenocarcinoma*.

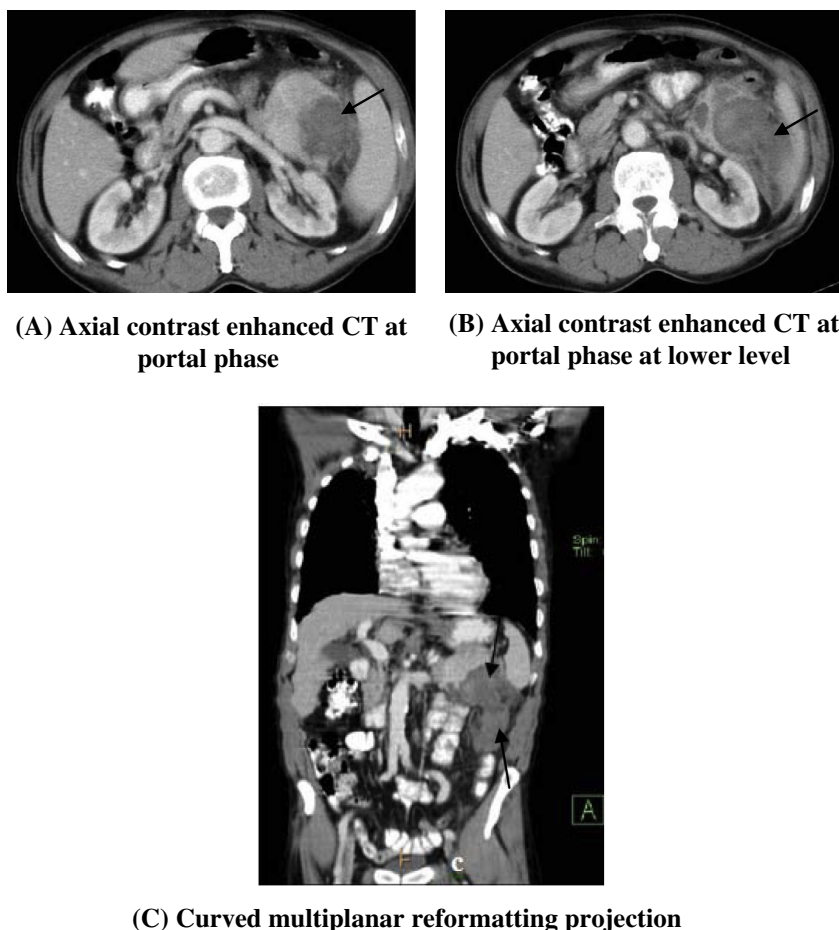


Fig. 2 (A–C) 60 year-old-patient presented with abdominal pain and vomiting. **Axial contrast enhanced CT** (A & B) shows pancreatic tail complex cystic & solid mass (black arrow) (C) **multiplanar reformatting** shows pancreatic tail mass (black arrows) **Excised Biopsy revealed:** cyst adenocarcinoma.

2. Patients and methods

2.1. Population

This study included twenty patients with clinical and laboratory findings of pancreatic mass (16 males and 4 females) or as a follow-up study for pancreatic cancer referred to the CT unit in Tanta university hospital in the period from February 2012 to August 2013 and their ages ranging from 30 to 70 years with mean age: 58.0 years \pm 8.2 [SD]. Patients with chronic renal impairment (high serum creatinine) or previous allergy to the contrast media were excluded from the study. This study was approved by the ethics committee of Tanta Faculty of Medicine; an informed consent was obtained from all patients after full explanation of the benefits and risks of the procedure.

2.2. Methods

All patients were subjected to careful history taking, general and abdominal examination, laboratory and serological examinations, abdomino-pelvic ultrasound and multidetector computed tomography.

2.3. Abdomino-pelvic ultrasound

Trans-abdominal ultrasound was the initial test. Ultrasonographic examination was done for all patients searching for signs of pancreatic mass. Scanning was done using 3.5 and 5 MHz curvilinear transducers (B-K Medica) after an overnight fast. The liver, gallbladder, pancreas, intrahepatic and extrahepatic bile ducts were evaluated. Any additional findings namely, ascites, enlarged lymph nodes were also evaluated.

2.4. MDCT technique

This study was performed using a 16 slice multi detector CT (Somatom, E-motion 16, Siemens Healthcare; Germany). Low residue diet was prescribed 24 h before the procedure and the patient was instructed to come to CT unit after completing fasting for about 4–6 h before examination. Reassurance and brief explanation of the procedure to the patient were given. All patients were examined in supine position, each patient was instructed to remain stable and do not move during examination. Also suspended breathing during scanning time was important.

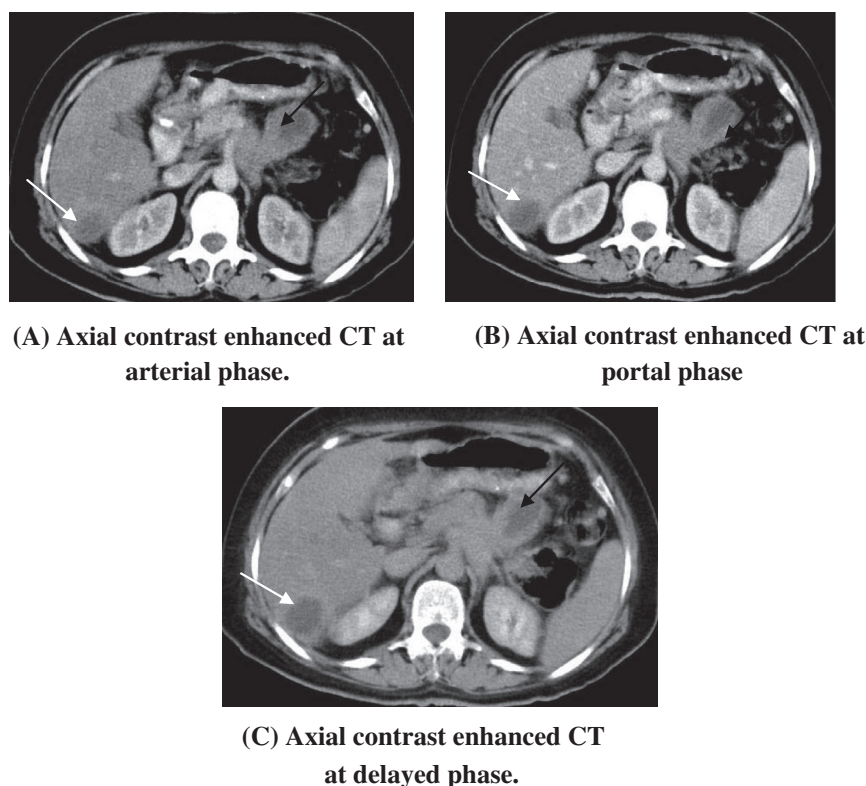


Fig. 3 (A–C) 55 year-old-patient presented with abdominal pain and jaundice. *Triphasic CT study* shows irregular contour of the pancreas with mixed cystic and solid mass seen inseparable from the pancreatic tail (black arrow) the lesion is hypo attenuated in relation to enhanced pancreatic parenchyma at arterial phase (A), porto-venous (B) and delayed phase (C). A hypodense focal lesion in right hepatic lobe showing marginal enhancement (white arrow) **Excised Biopsy revealed:** mucinous cyst adenocarcinoma.

2.4.1. Oral contrast regimen

Opacification of the gastrointestinal tract with oral contrast material was given routinely before CT scanning; one liter of diluted 2–4% non ionic contrast material was administered in three divided doses before the examination. The diluted contrast was prepared from 20 ml of non ionic contrast completed by 1000 ml of water, two doses of 400 ml of this diluted contrast was given orally 10 and 4 h before the examination and another 200 ml was given when the patient was on the scanner before starting the examination. The first dose was given to facilitate filling of distal small intestine and colon, the second dose was given to fill the proximal ileum and jejunum and the third cup was given when the patient is on the scanner to assure optimal filling of the stomach and duodenum. Precontrast scanning was acquired in all patients; it was performed from the level of diaphragmatic copula to the level of symphysis pubis for scanning of the whole abdomen.

2.4.2. Post contrast regimen

After the end of precontrast CT examination, post contrast scan was done after automatic injection of 100 ml non-ionic iodinated contrast ultravist 300 (300 mg iodine/ml) at a rate of 5 ml/s into the antecubital vein, the volume of contrast medium was based on the patients' weight. The volume of contrast medium delivered was 2 ml per kg of body weight with an average of 100–150 ml. The arterial phase starts 20–35 s after the start of injection of contrast medium. The porto-venous

and the delayed phase began 70 and 180 s after initiation of the contrast injection, respectively then image data were reconstructed and sent to a workstation.

2.4.3. The scan parameters

The scan parameters are tube current 120 kV and 400 mA, slice thickness 5 mm, collimation of 0.6 mm, pitch 0.6, 0.6-s gantry rotation time and table speed of 7.5–10 mm per rotation during a single breath-hold acquisition of 15–25 s.

2.5. Image analysis

Multislice computerized tomography allows examination of the pancreas with thin slice thickness (1 mm) or less during a short time of a single breath hold with high quality images. This allows application of different pancreatic scanning protocols, the best of which is a three phase protocol. The arterial phase is helpful for detection of hypervascular tumors, and obtaining CT angiography of peripancreatic vasculature to determine vascular involvement. The parenchymatous and portal venous phases are important for detection of hypovascular tumors that represent nearly all pancreatic carcinoma, and for detection of liver metastasis. Almost all of pancreatic adenocarcinomas are unresectable. MSCT is useful to prevent an unnecessary Whipple procedure (resection of the distal stomach, duodenum, and part or all of pancreas). Any of the following findings are CT signs of unresectability: liver metas-

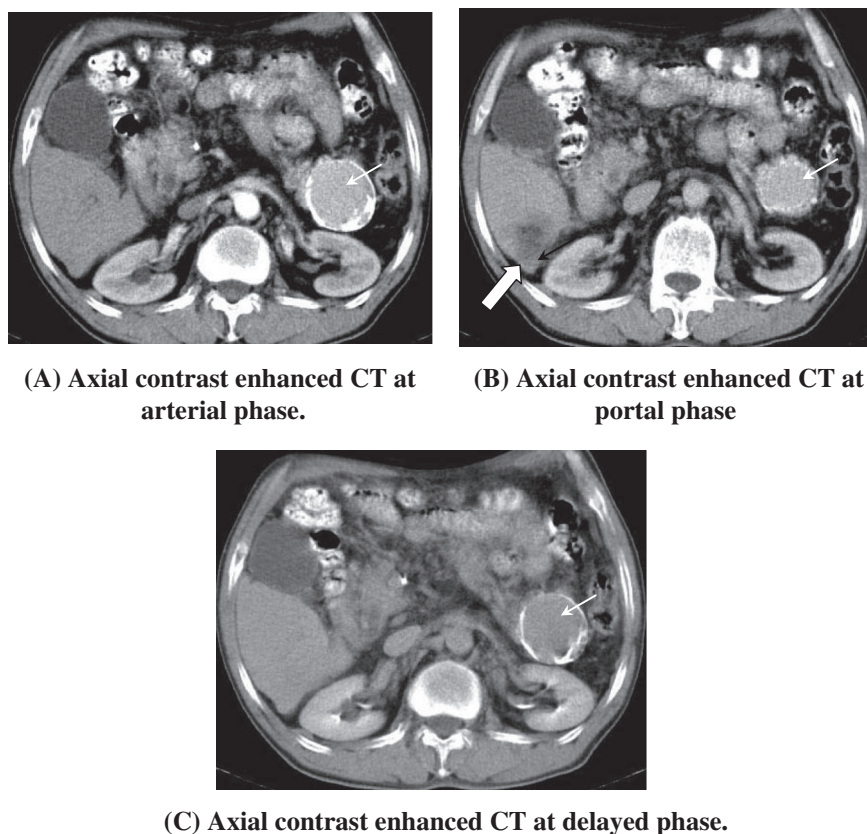


Fig. 4 (A–C) 63 year-old-patient presented with dyspepsia. **Triphasic CT study** shows well defined lesion with marginal calcification at the site of pancreatic tail (white arrow) appears in the arterial (A), venous (B) and delayed phase of the study (C). Right hepatic lobe hypodense mass with no evident of enhancement in all the phases (block arrow) **Excised Biopsy reveled:** pancreatic mucinous cyst adenocarcinoma.

tases, ascites, local extension (except duodenum), arterial encasement, venous occlusion, and lymph node enlargement outside the field.

2.6. Statistical analysis

The diagnostic efficacy of MDCT in the prediction of pancreatic masses and signs of unresectability was evaluated and compared with histopathological and surgical findings which were considered the gold standard of reference. Data entry was done by SPSS version 16 and analyzed by the same software. A P value <0.05 was considered significant.

3. Results

Twenty patients with pancreatic masses were evaluated during the period from February 2012 to August 2013 with the multi detector CT study. The final diagnosis obtained depends on histopathological biopsy and operative data.

This study included 20 patients (16 males and 4 females), with the commonest age of pancreatic masses between 50 and 60 years as shown in [Table 1](#).

As regards multislice CT manifestations of the pancreatic masses, well defined margins are detected in twelve cases, while the remaining eight cases appeared with ill defined margins,

seven cases appeared hypodense, and two cases appeared hyperdense. Eleven patients showed homogenous enhancement, nine patients showed heterogeneous enhancement. Only one case showed calcification, these data are shown in [Table 2](#), [Figs. 1–5](#).

Other multislice CT findings associated with pancreatic masses were intrahepatic biliary radicals dilatation which appeared in nine patients, dilated pancreatic duct appeared in five patients, six patients showed dilated common bile duct, hepatic metastasis was detected in five patients, two patients showed duodenal invasion, and four patients showed enlarged lymph nodes. Two patients showed ascites and two patients showed vascular invasion. In addition to the previously detected finding, other associated extra pancreatic lesions were observed on the multislice CT study. There were eight patients with chest manifestation, one patient showed adnexal cystic lesion and one patient showed osteolytic bone lesion and this is shown in [Table 3](#).

The studied 20 patients were subjected to histopathological study. Intra-operative tru-cut biopsy was done for 6 patients; percutaneous CT guided needle biopsy was done for 6 patients, percutaneous US guided biopsy was done for 5 patients, and ERCP biopsy was done in the remaining 3 patients. Pancreatic ductal adenocarcinoma appeared in eight patients, cyst adenocarcinoma in one patient, infiltrative periampullary in two

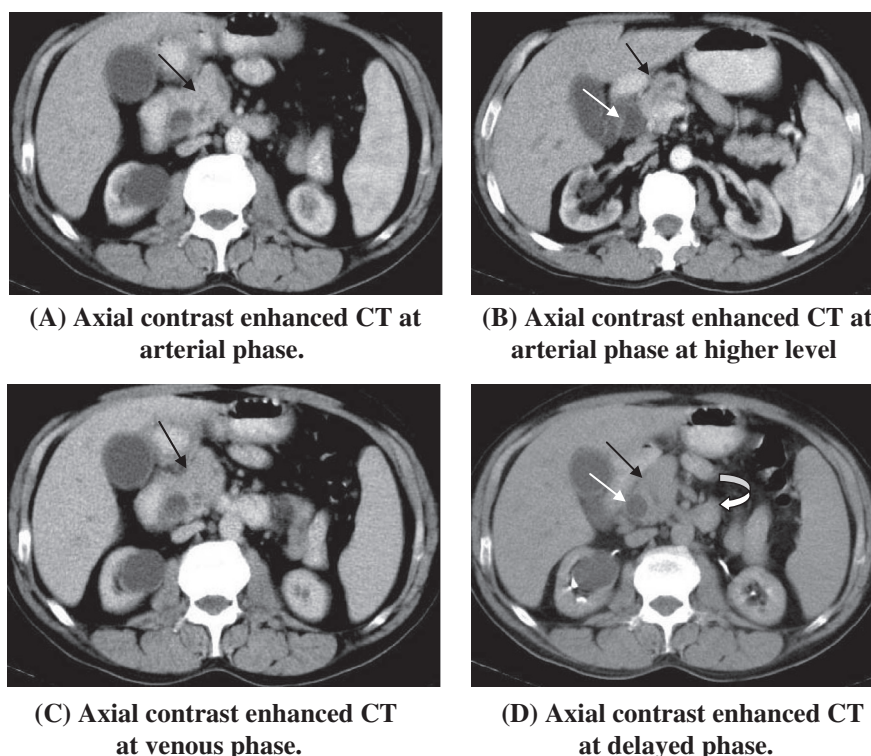


Fig. 5 (A–D) 53 year-old-patient presented with jaundice & abdominal pain. **Triphasic CT study** shows bulky head of pancreas with small hypodense focal area (black arrow), dilated CBD & prominent pancreatic duct (white arrow) seen in arterial (A & B), venous (C) and delayed (D) phases, also small peripancreatic and para-aortic lymph nodes (curved arrow).

Table 3 Show different multislice CT findings associated with pancreatic masses detected in the studied 20 patients.

CT finding	Number of the patient	Percentage (%)
I.H.B.R.D.	9	45
Dilated pancreatic duct	5	25
Dilated C.B.D.	6	30
Hepatic metastasis	5	25
Duodenal invasion	2	10
Enlarged L.Ns	4	20
Ascites	2	10
Peripancreatic vascular invasion	2	10
<i>Chest lesions</i>		
Pulmonary	6	30
● Inflammatory reactions	1	5
● Deposits	3	15
● Atelectatic bands	1	5
● Pneumonic Patches	1	5
Pleural effusion	2	10
Adnexal cystic lesions	1	5
Osteolytic bone lesion	1	5

patients, intraductal papillary mucinous tumor in two patients, mucinous cyst adenocarcinoma in one patient, mucinous cyst adenoma in four patients and pseudo pancreatic cyst in two patients as shown in [Table 4](#).

According to predicting resectability by using the multislice CT on the studied 20 patients, 6 patients were considered

suitable for tumor resection and 14 patients were considered inoperable with unresectable tumor, one out of the 6 operable patients was unresectable during operation due to the invasion of the superior mesenteric vein with infiltration of the mesenteric root, the resected [Table 5](#) pancreatic masses show free surgical margin (negative for malignant cells) on histopathology results as shown in [Tables 5 and 6](#).

4. Discussion

When pancreatic mass is suspected clinically, various imaging modalities have been employed for further evaluation of this mass. The use of non-invasive techniques including US and CT permits a more frequent diagnosis of pancreatic neoplastic lesions (7).

Recent improvements in imaging techniques have made it possible to improve the diagnostic accuracy for detection, staging, and indicating surgical resectability of pancreatic cancer (8).

Multislice CT is the most efficient non invasive technique in the assessment of pancreatic cancer, it allows excellent visualization of the pancreatic cancer during the different stages of contrast enhancement, thereby facilitates detection of small pancreatic lesions and evaluation of peripancreatic structures (9).

In our study, our data were obtained from clinical examination, real time ultrasonography, multislice CT and finally histopathological examination.

In this study, pancreatic neoplasms are more common in males 80% than females 20%, this is in agreement with Jemal

Table 4 Histopathological diagnosis of the studied 20 patients with pancreatic mass.

Pathology	Number of the patients	Percentage (%)
Adenocarcinoma	8	40
Cyst adenocarcinoma	1	5
Infiltrative periampullary	2	10
Intraductal papillary mucinous tumor	2	10
Mucinous cyst adenocarcinoma	1	5
Mucinous cystadenoma	4	20
Pseudo pancreatic cyst	2	10

Table 5 MDCT prediction of the resectability in 20 patients with pancreatic mass.

Prediction of the resectability	Number of the patient	Percentage (%)
Resectable	6	30
Non resectable	14	70

Table 6 MDCT resectability correlated with surgical and histopathological results.

Prediction of the resectability	Number of the patient	Percentage (%)	P value
MDCT resectable	6	30	<0.05
Surgical resectable	5	25	
Histopathological resectable	5	25	

et al., (10) who stated that the age-adjusted incidence rate of pancreatic neoplasm is greater in men than in women and in contrast with John et al. (11) who found that recently more women are developing the pancreatic malignancy.

The age group mostly affected by pancreatic neoplasm in this study is 60–70 years. John et al. (11) found that those aged 60 < 80 years are the most affected group with pancreatic neoplasms and uncommon in those younger than 40 years.

In this study, pain is the most common complaint. It accounts for 60% of the examined patients. Jaundice was the second common complaint in 45% of patients. This is similar to the statement of Takhar et al. (3) and differs from the result of Russel et al. (12) who stated that obstructive jaundice was seen in 85% of patients. John et al. (11) also stated that obstructive jaundice is seen in 75% of patients and about 46% of their patients were presented with pain and jaundice.

In this study the size of the masses in 4 patients was more than 7 cm, two of these patients had cystic and one of them had solid mass. In 8 patients the size of the mass ranged from 3 to 7 cm. The last 8 patients had small mass less than 3 cm, Tatli et al. (13) found that the mean largest dimension is 6.0 × 5.0 cm.

In our study multi slice CT could detect the pancreatic masses in the selected 20 patients resulting in sensitivity of 97.7% in detection of pancreatic masses and resectability. Scaglione et al. (14) reported sensitivity as high as 90 to 97% in the detection of pancreatic masses.

In our study multislice CT could identify 10 (50%) solid, 8 (40%) cystic and 2 (10%) mixed lesions. Curry et al. (15) stated that cystic pancreatic tumor accounts for only 1% of the pancreatic neoplasm.

Becker and Stommer (16) reported that 60% of pancreatic tumors occupied the head of pancreas, 10% the body, about 5% the tail and the remaining 25% were diffusely involved, in our study 45% of tumors occupied the head of the pancreas, 25% the body, 5% the tail and 10% the body and tail, so it was logical to have 45% of patients with a clinical history of jaundice because 45% of the masses were in pancreatic head.

In our study adenocarcinoma as reported by pathological studies was the most common pathological finding in about 40% of the patients, this is in agreement with Cascinu et al. (17) who stated that adenocarcinoma accounts for up to 70% of the pancreatic malignancies.

In this study, the most common reported associated extra pancreatic finding is dilated intra hepatic biliary radical which is seen in 9 patients (30%), this sign is seen in patients with head masses. John et al. (11) stated that ductal dilatation occurs in 58% of patients with pancreatic neoplasm and ductal dilatation proximal to the obstructing tumors was detected in approximately 88% of pancreatic head tumors and 60% of body tumors.

Liver metastasis could be detected by multi slice CT in 5 patients (25%). This comes in agreement with Murfitt (18) who stated that metastasis to the liver occurs in approximately 17–55% of the patients.

Chest distant metastatic manifestation was the most common associated extra pancreatic finding in the current study. This was reported in 35% of the patients and osteolytic bony lesion in 5% of the patient. This comes in agreement with the statement of Kloppel (8) who stated that metastasis to lung, pleura and bone is only seen in advanced tumor stages.

In the absence of distal distant metastasis, vascular invasion is the single most common criterion detected in patients with pancreatic lesions. Detection of vascular invasion is a key to the surgeon in preoperative planning because the posterior lateral surface of the portal and superior mesenteric vein if invaded can be evaluated by surgical procedure as advanced pancreatic tumor (Vargas et al. (19)).

In our study we reported 14 (70%) patients with pancreatic cancer who had unresectable tumors and 6 (30%) patients had resectable tumors, and the causes of unresectability were hepatic metastasis, distant lymph nodes involvement, vascular invasion and ascites. This comes in agreement with Li et al. (20) who stated that about 25–30% of patients have resectable disease at the time of presentation. Our study has limitations, firstly only limited number of resectable tumor cases was assessed and secondly no patients with unresectable tumors underwent laparotomy.

In conclusion, Contrast-enhanced multiphase pancreatic imaging by multislice computerized tomography (MSCT) with its postprocessing techniques represents the image of choice for diagnosis and predicting pancreatic masses and resectability.

Conflict of interest

Authors reported agreement and no conflict of interest.

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